ASKAP Commissioning Update

Welcome to the first in a resumed series of ASKAP commissioning updates – short newsletters that describe the status of the telescope and recent developments in commissioning and early science. The goal of these updates is to keep the science community informed of our progress towards full science operations.

Intensive effort to solve correlator stability and reliability issues

Earlier this year, the commissioning team identified several problems with the output of ASKAP's correlator. These include inconsistencies in the bandpass (blocks of several channels with different phase or amplitude than expected), narrow spikes that don't seem to be caused by radio frequency interference and loss of packets flowing between the correlator and the science data pipeline.

As the complexity of the ASKAP digital system increases with the number of antennas in the array, these problems have grown in severity to the point where it was necessary to halt early science operations.

The ASKAP signal path

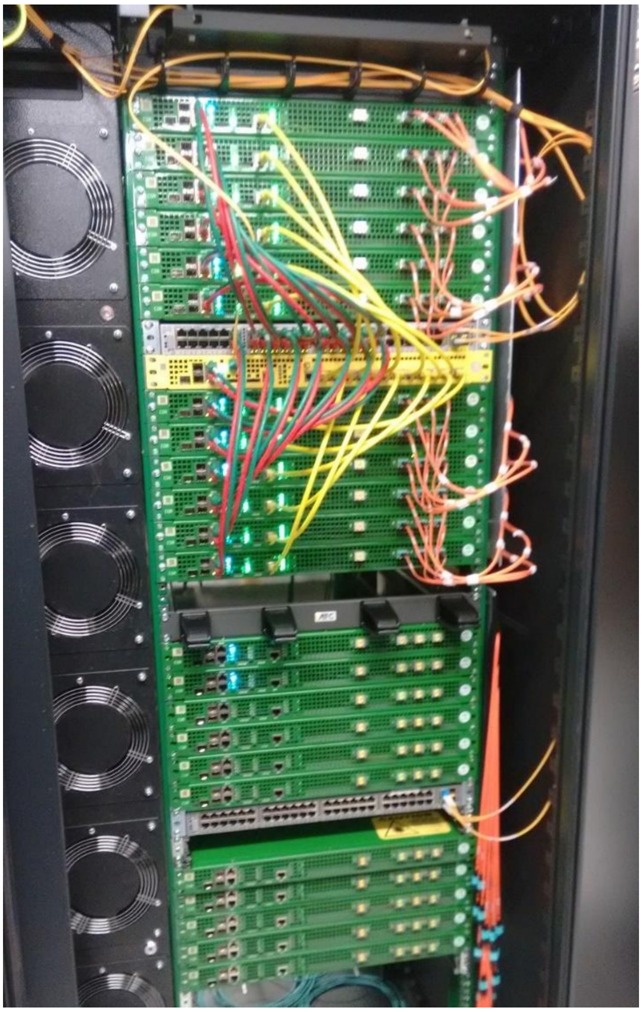
Signals received by the ASKAP phased array feeds are transmitted on optical fibres back to the central control building, where they are digitised. After sampling, the signals are divided in frequency by a first-stage poly-phase filter-bank before beamforming. The output of each beam is then further subdivided in frequency before being correlated with like beams from all other antennas.

One of the issues we have encountered involves the system designed to keep all correlator inputs precisely aligned in time. As the array expands, this becomes more challenging and raises difficulties that were not encountered in laboratory tests with a limited quantity of hardware. Occasionally, antennas can drop out of alignment mid-observation, causing data corruption. We have identified one major cause of this problem but more testing is required to make sure it has been solved.

After correlation, data are integrated in memory modules within the signal processing hardware. The integrated visibilities are downloaded once every 5 seconds by the "ingest" pipeline, a series of high-performance software applications designed to capture, calibrate and image the visibilities.

Another problem we have encountered is that this download mechanism frequently stalls, leading to missing frequency channels.

Investigations over the past week have shown that the internal communications channel between FPGA devices in the signal processing hardware can block due to inconsistent states on the transmit and receive sides, though the exact logical cause is yet to be determined.



One of the complete correlator blocks (top) and a partially-installed block below.

Memory management

The presence of artefacts in the correlator output may be related in part to the communication problems described above. However, one of the major changes that occurred around the time these problems escalated in severity was the inclusion of a new memory control module in the signal processing firmware.

Integrated data are stored in DRAM prior to upload, but the clocking requirements for DRAM modules are quite different to those of the signal processing FPGAs, making the memory control module a complicated piece of logic. It is likely that some of the remaining problems will be solved by further tuning this interface and the associated memory timing calibration system. This will be a priority once the communications problems have been resolved.

Significant progress has been made bringing new and existing staff up to speed on the inner workings of the digital hardware and several smaller problems have already been identified on the way to an overall solution. This pause in operations should lead to a much more stable system with which to conduct future early science observations.

On-dish calibration system installation

While our digital electronics engineers work on the correlator, staff at the observatory have been busy installing (among other things) hardware for the ASKAP On-Dish Calibration system.

The ODC consists of a small LPDA antenna mounted at the vertex of each 12m dish, connected back to the central building by optical fibre. This antenna can be fed low-power broad-band noise or a synthesised waveform.

A copy of the radiated signal is returned from the antenna and fed into the digitisers alongside the signals received from the PAF ports. When turned on, this system provides a signal that correlates with all PAF outputs and can be used as a stable gain reference. This allows us to track any changes in the complex gains of the PAF elements, which can be corrected for by altering the beamformer weights.

Periodic use of the ODC system should help stabilise the antenna beam patterns over time and may also be useful in determining polarisation leakage parameters.

Roughly 20 of the antennas have had this system installed and we are intending to include an ODC test alongside every beamforming task once the array is back online for early science.

New file system brought online at Pawsey

The Pawsey centre has finished commissioning a new Lustre file system connected to the Galaxy super-computer. 1 PB of space on this new system has been allocated to the real-time ingest of data from ASKAP, using a dedicated metadata server that should avoid load issues due to multi-user access patterns that may have impacted the performance of the real-time data acquisition system in the past.

For now, the intermediate products of the science data pipeline will still be written to the older /scratch2 filesystem, but we are negotiating how to best proceed when /scratch2 is decommissioned later in the year.

Relocation of the existing online measurement set collection to the new filesystem has at least made more space on /scratch2 available for continued processing of the early science data obtained last year, though it is still difficult to work on more than a few of the datasets simultaneously.

Antenna 1 gearbox swap complete

A seized azimuth gearbox on antenna 1 was recently swapped for a working unit from one of the other antennas that does not currently have a PAF installed.

This process provided an opportunity for observatory mechanical engineering staff to gain direct experience with the gearbox mechanisms, a first since they were installed by the manufacturer several years ago.

The failed unit will be sent for inspection and rework while CSIRO is in the process of sourcing spare parts for the future.

In response to the need for more regular monitoring of drive train health, we have developed a standardised torque test program that drives all operational antennas through a predetermined sequence. Analysis of the current required to drive each motor during this test can provide early warning of excessive binding in the drive train. Because of these tests, some adjustments on the meshing of other gearboxes has been performed. Overall, the remaining antennas seem to be in a good state.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.csiro.au

FOR FURTHER INFORMATION

CSIRO Astronomy and Space Science
Aidan Hotan
t +61 8 6436 8543
e aidan.hotan@csiro.au
w www.csiro.au/askap